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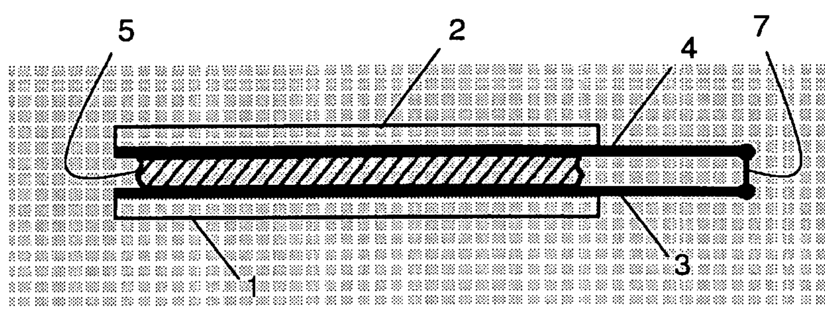

(57) Abstract: The invention relates to a laminate structure comprising a first active layer having a first electrode potential, a second active layer having a second electrode potential, wherein the second electrode potential being different from the first electrode potential and wherein the first and second active layers are arranged at a distance from each other, and wherein the laminate further comprises a third layer of an electrically weakable adhesive at least partly bridging said distance between the first and second layers.

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LAMINATE STRUCTURE

Field of invention

The present invention relates to a laminate structure which make use of an electrically weakable adhesive and which may easily be broken or weakened.

Technical Background

It is well known in the art that polymer chains can be broken by the application of a voltage. This is for example discussed in a review article by G.S. Shapoval(Cathodic initiation of reactions of macromolecule formation and degradation, Theoretical and Experimental Chemistry, Volume 30, Number 6, November 1995).

US 6,620,308 B2 discloses a material for use in the airplane industry. As is evident from the published patent, the material has been developed under the supervision of the U.S. Department of the Air Force. The material is developed for use as coatings and adhesives. It is further elaborated in US 6,620,308 that the adhesive bonds and polymeric coatings are commonly used in the assembly and finishing of manufactured goods. It is stated that adhesive bonds are used in place of mechanical fasteners, such as screw, bolts and rivets, to provide bonds with reduced machining costs and greater adaptability in the manufacturing process. It is further discussed that adhesive bonds distribute stresses evenly, reduce the possibility of fatigue, and seal the joints from corrosive species. It further asserts that, similarly, polymer-based coatings are commonly applied to the exterior surface of the manufactured products. These coatings provide protective layers that seal the surface from corrosive reactants, as well as provide a painted surface that can the aesthetically pleasing.

The composition disclosed in US 6,620,308 B2 has a matrix functionality and an electrolyte functionality, wherein the electrolyte functionality is provided by a block copolymer or a graft copolymer. The matrix functionality provides an adhesive bond to a substrate, and the electrolyte functionality provides sufficient ionic conductivity to the composition to support a faradic reaction at an interface with an electrically conductive surface in contact with the composition, whereby the adhesive bond is weakened at the interface. The composition may be a phase-separated composition having first regions or substantially matrix functionality and second regions of substantially electrolyte functionality.

US 6,620,308 B2 discloses that the electrical power supply may supply direct or alternating current. It continues by stating that direct current may be supplied from a battery or an AC-driven DC-power. The composition is applied between two conductive surfaces and by applying the voltage to the two conductive surfaces the bonding between the composition and one of the conductive surfaces is broken. Thus, a battery may be used and thereby be connected with one pole to one of the conductive surfaces and the other pole to the other conductive surface. US 6,620,308 B2 mentions that the conductive surfaces may be formed of wire mesh, metal foil, and a conductive coating, e.g. a silver-filled epoxy.

Summary of invention

It is an object of the invention to provide a laminate structure which may easily be broken.

This object has been achieved in accordance with the invention with a laminate structure comprising a first active layer having a first electrode potential, a second active layer having a second electrode potential, wherein the second electrode potential being different

from the first electrode potential and wherein the first and second active layers are arranged at a distance from each other, and wherein the laminate further comprises a third layer of an electrically weakable adhesive at least partly bridging said distance between the first and second active layers.

The first and second active layers are adapted to be electrically connected to each other via a conductor being separate from the third layer, thereby forming a closed circuit from the first active layer, via the conductor to the second active layer and from the second active layer to the first active layer via the third layer.

The different electrode potentials may be provided by forming the first active layer of a first material having the first electrode potential and forming the second active layer of a second material having the second electrode material. It may also be accomplished by providing a first electrolyte providing the first electrode potential in connection with the first active layer and providing a second electrolyte providing the second electrode potential in connection with the second active layer. The electrically weakable adhesive may be one of said electrolytes. The design may also be a combination with different materials in the active layers and with different electrolytes in connection with respective active layer. In accordance with one embodiment the laminate structure comprises a first active layer of a first material having a first electrode potential and a second active layer of a second material having second electrode potential. Between those active layers is a layer of an electrically weakable adhesive arranged. This adhesive also acts as the electrolyte for the electrodes.

By providing a laminate structure of materials with different electrode potentials and an electrically weakable adhesive it is possible to accomplish a laminate

structure that is easily broken by simply short-circuiting the electrodes formed by the first and second active layers. This short-circuiting may be performed by closing an integrated switch, by providing an external tool basically comprising a conductor being connectable to the first and second layers, or even simply by short-circuiting it by putting a finger in connection with both the first and second active layers and thereby letting the moisture on the finger act as a conductor. The short-circuiting might also be provided with any suitable metallic object, such as a key, a bottle opener or the like. By providing the different electrodes within the laminate structure, the need for an external power source is dispensed with. Thereby the laminate structure may be used for applications also where it would be inconvenient to bring a power source. It is e.g. especially convenient to be able to dispense with the external power source when it comes to package applications. When buying a package provided with the laminate structure above, the package may easily be opened by short-circuiting the laminate structure such that the glued opening is easily brokened. Since the laminate structure internally provides the necessary energy, the buyer may open the package without the need for any external power source. This is especially useful if the buyer wants to open the package before coming home or when on a picnic.

Preferred embodiments of the invention appear from the dependent claims.

The third layer may bridge said distance between the first and second active layers. By letting the third layer bridge the distance between the first and second active layers a simple design of the laminate structure is provided. The laminate may easily be provided by providing the first active layer, applying the electrically weakable adhesive onto the first active layer and then providing the second active layer onto the electrically weakable adhesive.

The distance between the first and second active layers may be bridged by the third layer and a fourth layer formed of an electrically conductive adhesive. With this design it is possible to provide a semi-finished product with one of the active layers already provided with the electrically weakable adhesive. When closing the laminate structure a conventional electrically conductive adhesive is applied to the other active surface or to the electrically weakable adhesive and the laminate structure is finalised.

The laminate structure may further comprise a first substrate with a surface supporting the first and second active layers, wherein the first active layer may be separated from the second active layer a distance along the surface of the first substrate.

In this way, it is possible to pre-manufacture parts of the structure with the active surfaces on a substrate or carrier layer. It may be noted that supported does not necessarily mean that the active surfaces need to be in direct contact with the first carrier layer. In one embodiment the first active surface is laminated directly onto the first carrier layer, whereas significant portions of the second active surface is laminated onto an insulating layer laminated onto the first active surface. The laminate structure is still supported by the first carrier layer.

The first substrate may be formed of a non-conductive material. In this way, the conductors may simply be provided as printed or laminated conductors on the non-conductive material. There will be no immediate need for more complicated laminate structures with insulating layers, etc.

The first substrate may be formed of plastic or of paper board. These materials are preferred since it is easy to provide a connecting element or package in plastic or in paper board. They are also normally non-conducting making it easy to provide them with an

electrical circuitry using e.g. a printing or laminating technique.

The first substrate may be connectable to a second substrate, wherein the electrically weakable adhesive is arranged to be located between the first and second substrate. This is especially suitable for package applications where the first and second substrates are formed of different portions of a paper package and wherein the active surfaces are applied to the surfaces of respective substrate.

The laminate structure may further comprise a non electrically weakable adhesive arranged as a layer arranged to be located between the electrically weakable adhesive and the second substrate. If both active layers are formed on the first substrate and the electrically weakable adhesive bridges the distance between the active layers, this non electrically weakable adhesive may also be non-conductive. If the second substrate carries the second active layer, the non electrically weakable adhesive need to be electrically conductive in order to form an electric circuit between the first and second active layers via the electrically weakable adhesive.

The laminate structure may further comprise a plurality of said first active layer of a first material having a first electrode potential, and a plurality of said second active layer of a second material having a second electrode potential, wherein said first and second layers are arranged in a plurality of pairs wherein respective first active layer and respective second active layer of each pair is separated from each other a distance, and wherein each distance, a part from a least one distance being bridged by the electrically weakable adhesive, is bridged by an electrolyte material, and wherein the pairs are connected to each other by connecting the first active layer of a first pair to the second active layer of a second pair. By providing a plurality of alternately arranged first and second active

layers a stacked battery is provided. In this way, it will be possible to provide a greater voltage and electric current through the electrically weakable adhesive, thereby accomplishing a more distinct or more rapid weakening of the laminate structure.

The laminate structure may further comprise a first substrate with a surface supporting said plurality of first and second active layers, wherein each respective first active layer is separated from each respective second active layer a distance along the surface of the first substrate. By providing the plurality of first and second active surfaces along the substrate surface it is possible to provide the higher voltage without any significant increase in space requirement. On a package solution it will only slightly increase the thickness of the package material compared to a laminate structure with a single set of one first active layer and one second active layer.

The laminate structure may further comprise a switch member by which the first and second active layers are electrically connectable to each other. In this way, it is possible to secure that the electrical connection is provided with controlled electrical resistance.

The laminate structure may further comprise a first connector electrically connected to the first active layer and a second connector electrically connected to the second active layer, wherein the first and second connectors are adapted to be electrically connected to each other by an external connector. This is a simple design where the active surfaces are simply provided with an externally accessible portion. The external connector may as discussed above be an especially adapted tool but it may also be a key, bottle opener or the like, commonly accessible to a user.

Brief description of the drawings

The invention will by way of example be described in more detail with reference to the appended schematic drawings, which shows presently preferred embodiments of the invention.

Fig 1 shows a first basic structure in which different layers are connected to each other using an electrically weakable adhesive.

Fig 2 shows in an exploded view a first embodiment of a second basic structure with the active surfaces arranged on the same side of the adhesive layer.

Fig 3 shows in an exploded view a second embodiment of the second basic structure.

Fig 4 shows a cross-section of the structure in fig 3.

Fig 5 shows in an exploded view of a third embodiment of the second basic structure.

Fig 6a shows a sandwich structure comprising a plurality of first and second active layers.

Fig 6b shows a flattened structure comprising a plurality of first and second active layers.

Fig 7 shows an embodiment with a second adhesive interposed between the electrically weakable adhesive and one of the active surfaces.

Fig 8 shows an embodiment where twelve packages are being held together by two panels.

Fig 9 shows a panel as shown in fig 8.

Fig 10a shows two packages adapted to be held together to form a distribution unit.

Fig 10b shows in enlargement a portion of the package of fig 10a.

Fig 11a and 11b shows a set of secondary articles in the form of a cup and a saucer connected to a handling element.

Fig 12 shows a handling element connected to two secondary articles in the form of two packages.

Fig 13a shows in cross-section a package.

Fig 13b shows in cross-section the package of fig 11a when opened.

Fig 14 shows a portion of a bottle neck provided with a screw cap.

Detailed description of preferred embodiments

The laminate structure described in the following makes use of an electrically weakable adhesive material. The inventive laminate structure comprises active surfaces acting as electron and/or ion emitter and receiver connected with a bonding layer formed by the electrically weakable adhesive material. The bonding layer possesses adhesive properties and conductive properties. When a voltage is applied between the active surfaces and current flows through the bonding layer, bonds formed in or between the bonding layer and at least one of the active surfaces are broken or weakened. Thus, the bonding layer forms an electrically weakable adhesive.

The electrically weakable adhesive may bridge the complete distance between the active layers but may also be completed with additional layers of other materials capable of performing the necessary electrical and/or mechanical connection. Such materials may be conventional non electrically conductive adhesives, polymers, varnishes, or the like, or electrically conductive versions of respective material.

The electrically weakable material and different basic configurations of the active surfaces will initially be discussed in detail separately from the specific designs of the packages. The different designs of the packages will thereafter be discussed in detail. In some cases the design of the package will be discussed in combination with a specific kind of basic configuration. It should however be noted that this is for exemplifying purposes and that the different basic

configurations may be combined with the different designs of the packages.

According to one embodiment the bonding layer is composed of a composition possessing both matrix functionality and electrolyte functionality. The matrix and the electrolyte functionalities may be formed by a single phase or several separate phases.

The matrix functionality provides the adhesive properties necessary to bind surfaces to one another mechanically or chemically. The matrix functionality may be provided by polymers, polymer resins or fibres that possess adhesive properties.

The electrolyte functionality provides the ion conductivity necessary to support a faradic reaction, i.e. an electrochemical reaction in which a material is oxidized or reduced, or some other chemical/physical reaction. The materials are preferably chosen and designed such that the reaction occurs at the interface between one or both of the active surfaces and the bonding layer. Alternatively the bonding layer may be designed such that the reaction will occur within the bonding layer. This may, e.g., be accomplished by providing islands of a material with electrolyte functionality within the matrix material. The electrolyte functionality may be provided by adding a salt to the material or by modifying the polymer so that it includes ion-coordinating moieties.

The electrically weakable adhesive used in the inventive packages may be the electrochemically disbondable composition ElectRelease™ supplied by EIC laboratories and disclosed in more detail in US 6,620,308.

Fig 1 shows a common basic structure comprising a first carrier layer 1 and a second carrier layer 2. A first active layer 3 is laminated on the first carrier layer 1. A second active layer 4 is laminated on the second carrier layer 2. The active layers are bonded

together by a bonding layer 5, comprising an electrically weakable adhesive.

The electrical potential between the active layers 3, 4 is adapted to be provided by making the active layers 3, 4 of different materials with different electrode potentials. If the two active layers 3, 4 are connected, e.g. by moving a switch 7 to a position where it connects the two layers 3, 4, a closed circuit is formed and current will flow through the bonding layer 5, thereby causing the adhesive bond to break or to weaken. For example, copper and graphite can be used as active layers 3, 4 with different potentials. This design will create a flow of direct current between the active layers 3, 4 via the bonding layer 5.

By providing the active surfaces of different electrode potential an electrochemical cell in which electrical power is produced by a chemical reaction is provided. The electrochemical cell comprises basically two electrodes (the plus pole and the minus pole, respectively) connected to each other by an electrolyte and by an outer electrical circuit. When the cell is activated the electrical current runs in the outer circuit from the plus pole to the minus pole and in the electrolyte back from the minus pole to the plus pole. The electric current is formed of a transport of an electrical charge. In the outer circuit this transport of charges is accomplished by electrons in movement from the minus pole to the plus pole. In the electrolyte the transport is accomplished by ions; negative ions in movement from the plus pole to the minus pole, and positive ions in movement in the opposite direction. By providing the possibility of movement of the electrons in the outer circuit the chemical reaction in the electrochemical cell may continue. At the minus pole the electrons are produced by the material loosing their electrons (oxidation) and at the plus pole they are

consumed by materials receiving the electrons (reduction).

In order to investigate the battery structure a number of different battery structures were prepared using ElectRelease as the electrically weakable adhesive. The structures were cured for 1 hour at 80 °C in a convection oven. Battery potentials immediately after fabrication are given in Table 1.

Table 1: Battery potentials after fabrication

Type no	Battery type	Electrolyte	Voltage
1	Pb/PbO_2	ElectRelease	~ 0.8 V
2	Zn/MnO_2	ElectRelease	~ 1.0 V
3	Cu/Al	ElectRelease	< 0.2 V
4	Ag/MnO_2	ElectRelease	< 0.2 V
5	Al/air	ElectRelease	~ 0.2 V

Battery type no 1 was produced by disassembling a conventional 6V battery and then using the electrodes therein as the electrodes separated by the ElectRelease as the electrolyte. Battery type no 2 was produced using zinc-foil and manganese dioxide foil glued together with ElectRelease and battery type no 3 was produced using copper foil and aluminum foil. Battery type no 4 was produced using screen printed silver and a printed mixture of MnO_2 powder in carbon screen printing paste. Battery type no 5 was prepared by wetting a filter paper with ElectRelease and then gluing it to an aluminium foil. Steel wool was glued on top of the filter paper as a contact for the air electrode. The ElectRelease was applied with a thickness of about 200µm.

When short circuiting a Zn/MnO_2 battery with ElectRelease electrolyte a current was measured during the first five minutes. The current quickly reached a current of about 7µA and then slowly decreased during the five minutes to about 6µA. This indicates an ongoing

discharge process. Disbonding was however not observed after five minutes.

A number of Zn/MnO_2 battery structures was produced and was left over weekend. Some of the samples were left short circuited and some open. None of the open samples had disbonded after the weekend (>48hours). A plurality of the short circuited samples had disbonded cleanly in the same manner as has been observed in tests where an external voltage has been applied. Disbonding occurred at the Zn electrode and the disbonded surface was clean. Disbonding was investigated by manually applying a gentle pulling force to the samples.

Other conceivable material combinations for providing the electrode potential are, but not limited to: Pb/PbO_2,Cu/Al, Ag/MnO_2, Al/air, Zn/air, $Li/SOCl_2$, Li/SO_2, Li/MnO_2, Mg/MnO_2, Zn/HgO, Zn/carbon, Cd/HgO, Zn, Ag_2O, Zn/O_2, Zn/HgO.

Fig 2-5 show embodiments wherein the active surfaces are arranged on the same side on a carrier layer. In fig 2, 3 and 5, the different layers are for clarity reasons illustrated at a distance from each other. However, it is apparent that in practice the layers forms a laminated structure. From the description below it will follow in which cases the different disclosed layers need to be in direct contact with each other and when there may be one or more additional, non-disclosed layers between the disclosed layers. It may also be noted that in direct contact may dependent upon the situation mean in mechanical contact or in electrical contact.

Fig 2 shows an embodiment wherein the active surfaces 3, 4 are arranged on the same side of the bonding layer, instead of being provided as two separate layers 3, 4 on either side of the bonding layer 5 as in fig 1a-c. The structure comprises two carrier layers 1, 2 that are to be delaminated. The carrier layers 1, 2 may, e.g., be made of paper, paper board or plastic, but other materials are contemplated. The active surfaces 3, 4 are

arranged on one side of the bonding layer 5 and are separated from each other a distance d along the surface 5a of the carrier layer 1.

The active surfaces 3, 4 may be applied to the first carrier layer 1 using any conventional method, they may e.g. be printed or laminated onto the carrier layer 1. The active surfaces 3, 4 may be made of any conductive material, e.g. metal ink or foil, having different electrode potential. The bonding layer 5 is provided between respective active surface 3, 4 and the second carrier layer 2, thereby bonding the active surfaces 3, 4 to the second carrier layer 2 and in turn thereby bonding the two carrier layers 1, 2 to each other. The bonding layer 5 typically reaches the first carrier layer 1 in the small accessible area formed by the gap or distance d between the active surfaces 3, 4. As shown in fig 2, one of the active surfaces 3 has an area of distribution formed as an open half-circle partially enclosing the other active surface 4. This other active surface 4 has an area of distribution formed as a circle. The two active surfaces 3, 4 form a gap formed as a part of a ring, in this case a part of a circular ring, having a width defined by the above mentioned distance d.

The active surfaces 3, 4 are also connectable to each other via a circuit 9 comprising a switch 7. The electrode potential is shown as a voltage supply 6.

When the switch 7 is closed the electrode potential will cause a current to flow between the active surfaces 3, 4 via the bonding layer 5. This will cause the bonds in the bonding layer 5 or between the bonding layer 5 and one or both of the active surfaces 3, 4 to break or to weaken.

The accessible area of the first carrier layer 1 between the active surfaces 3, 4 may be made so small that even if the bonding layer 5 reaches the first carrier layer 1, the force needed to break the bond

between this accessible area and the bonding layer 5 is negligible.

Fig 3 and 4 shows yet another embodiment of a kind similar to the one shown in fig 2. In the embodiment of fig 3 and 4, the active surfaces 3, 4 are separated out of the plane by an insulating layer 10, but are still on the same side of the bonding layer 5 compared to the second carrier layer 2. The first active surface 3 is electrically connected to a connector 3a that formed part of the first active surface 3 in the embodiment of fig 2.

The insulating layer 10 separates the conducting elements and protects them from tear and wear. The connector 3a is in contact with the first active surface 3, but there is no direct connection between the connector 3a and the second active surface 4.

The second active surface 4 is provided on the carrier layer 1 as in the embodiment of fig 2. The insulating layer 10 is provided on this structure. Above the insulating layer 10 is the first active surface 3 arranged, and finally on top of this is the bonding layer 5 arranged. Since the first and second active surfaces 3, 4 are separated out of the plane, the first active surface 3 may be formed as a circular member completely surrounding the circular end portion of the second active surface 4. The active surfaces 3, 4 and the insulating layer 10 provides a gap between the active surfaces 3, 4 adapted to be bridged by the bonding layer 5. The bonding layer 5 may extend all the way from the second carrier layer 2 to the first carrier layer 1 and thereby provide a direct adhesion between the first and second carrier layer 1, 3.

Fig 5 shows an alternative embodiment to the one shown in fig 3 and 4, wherein the bonding layer 5 is adapted to carry a second bonding layer 11. This second bonding layer 11 may be formed of an adhesive that do not have to be conductive or electrically weakable. By providing this second bonding layer it is possible to

pre-manufacture the first carrier layer 1 with the active surfaces 3, 4 and the bonding layer 5, and then finally apply a second bonding layer 11 on the electrically weakable bonding layer 5 when the second carrier layer 2 is to be fastened to the first carrier layer 1. This additional bonding layer 11 may also be used in the design disclosed in fig 2.

An artisan will realise that there exists several alternatives to and combinations of the above disclosed embodiments. A brief discussion of some these alternatives follow hereinafter.

Respective active surface/layer may be arranged directly or indirectly via a laminating layer or the like on respective carrier layers. The active layer may in it self form both active surface and carrier layer.

As mentioned above the active surfaces may be separated in the plane and/or out of the plane. In order to separate the active surfaces out of the plane, an insulating layer, e.g. varnish, may be used. Insulating layers may also be used to separate conductive elements, such as active surfaces, from the carrier layer in cases when the carrier layer is conductive. Additional conductors may be arranged e.g. between the bonding layer and the second carrier layer in order to increase the conductivity in the plane of the structure.

The active surfaces are electrically conductive surfaces, conductors, and are preferably coated, printed or laminated on at least one carrier layer. However, if the carrier layers are electrically conductive and of different electrode potentials, no extra active surfaces are needed. The active surfaces may be composed of any electrically conductive material, e.g. copper, aluminium or graphite. The active surfaces may for example be in the form of a metal ink.

The carrier layer represent surfaces that are to be delaminated by the electrical force and can be of any conductive or non-conductive material, e.g. paper, paper

board, glass, metal, wood, moulded fibres or plastic. Two opposite sides of an opening of a package may for example represent a first and a second carrier layer. This will discussed in more detail below.

In accordance with one embodiment, the carrier layers are formed of carton boards and one of the active layers are formed of an aluminium foil with oxide. The active surface is moisturized with a salt solution and bonded together using a composition comprising polyurethane. When a voltage is applied over the laminate structure, the aluminium oxide on the positively charged foil dissolves whereby the laminate is broken. The electrical force may be applied by using another material for the formation of the other active surface, whereby the second material is chosen such that the aluminium will be the positively charged electrode.

In order to increase the power supply, several batteries can be printed on the carrier layer 1 and connected to the active surfaces. This enables all batteries and the active surfaces to be printed on the carrier layer in the same process step, which facilities the manufacturing of the structure.

This may e.g. be accomplished in an internal battery structure by providing a plurality of said first active layer 3 of a first material having a first electrode potential, and a plurality of said second active layer 4 of a second material having a second electrode potential, wherein said first and second layers 3, 4 are arranged in a plurality of pairs wherein respective first active layer and respective second active layer of each pair is separated from each other a distance, and wherein each distance, apart from a least one distance being bridged by the electrically weakable adhesive, is bridged by an electrolyte material, and wherein the pairs are connected to each other by connecting the first active layer of a first pair to the second active layer of a second pair.

Fig 6a discloses a first battery structure with a first carrier layer 1 (e.g. of paper board), a first active layer 3, a layer of an electrically weakable adhesive 5, a second active layer 4, a first active layer 3, a second electrolyte 5b, a second active layer 4, and a second carrier layer 2 (e.g. of paper board). The first pair A of first and second active layers 3, 4 are separated a distance, the distance being bridged by an electrolyte 5b. The second pair B of first and second active layers 3, 4 are separated a distance, the distance being bridged by an electrically weakable adhesive 5. The first active layer 3 of the first pair A is connected to the second active layer 4 of the second pair B. In this way, the potential difference created by the two pair structure will across the electrically weakable adhesive be twice the potential difference of a structure with only one pair of active layers or electrodes 3, 4. By electrically connecting the active layers being the farthest away from each other this potential difference will induce a current through the complete pack of pairs of active layers. In this case the second layer 4 of the first pair A is to be connected to the first layer 3 of the second pair. The structure may be provided with additional pair of active layers in order to further increase the available potential difference.

Alternatively, the pairs of active surfaces 3, 4 may be arranged side by side on one of the carrier layers 1 as shown in fig 6b. The first pair of active layers 3, 4 are separated a distance (along the surface of the first carrier layer 1) from each other, the distance being bridged by an electrolyte 5b. The second pair of active layers 3, 4 are separated a distance from each other (in the direction of the normal of the surface of the first carrier layer 1), the distance being bridged by an electrically weakable adhesive 5. The resulting potential difference across will induce a current through the complete pack of pairs once the active layers being the

farthest away from each other are connected to each other. In this case the first active layer 3 to the left in fig 6b is connected to the second active layer 4 at the top of the stack to the right in fig 6b. The structure may be provided with additional pair of active layers in order to further increase the available potential difference.

Both the stack in fig 6a and fig 6b may be ended with the layer structure of fig 2-5 as the pair of active layers with the distance between them being bridged by the electrically weakable adhesive.

Another embodiment with an additional adhesive electrolyte is shown in fig 7. If the electrically weakable adhesive 5 has good electrolyte properties only with one of the active surfaces 3 it is contemplated to use a second adhesive electrolyte 5b (not necessarily electrically weakable) as a layer between the electrically weakable adhesive 5 and the active surface 4 to which the electrically weakable adhesive 5 does not show good electrolyte properties. The non electrically weakable adhesive 5b is electrically conductive in order to form an electric circuit between the first and second active layers 3, 4 via the electrically weakable adhesive 5. In this case the non electrically weakable adhesive is conductive both for a simple sandwich structure as shown in fig 1 and for the structure as shown in fig 2-5. In this way the electrolyte properties may be optimised at both electrodes. Also in the design of fig 2-5, the additional adhesive 5b will be in contact with one of the active layers 3, 4 and the electrically weakable adhesive 5, whereas the electrically weakable adhesive will be in contact with the other active layer 4, 3. It may be noted that the additional adhesive 11 of fig 5 does not form part of the electric circuit between the first and second layers 3, 4.

The delaminating material structure comprising carrier layers, active surfaces and an electrically

weakable adhesive as described above may be used whenever the strength of a seal needs to be released, for example in the construction of packages. By providing the material structure as described above the packages may be opened by the application of a voltage. It can be used in all kinds of packages, such as cans, jars, bottles, cartons and blister packages. It may also be used together with all kinds of materials, such as paper, paper board, glass, metal, wood, moulded fibres or plastic. Two opposite sides of an opening of a package may represent a first and second carrier layer and the electrically weakable adhesive described above may be arranged between the carrier layers.

Furthermore, the controlled delaminating material may be used for collation of products in transit or handling and subsequent separation of the products, for separating packages bonded together and for tamper-proofing goods. It may also be used to limit or change the properties of a product before it is purchased in order to prevent theft. Collation of products, tamper-proofing a product or preventing theft of a product may be done by binding existing parts or elements of the product or products together or by binding additional elements to the product or products, using the controlled delaminating material.

Fig 8 shows an application wherein a full pallet of packages 50a-g are interlocked using a connecting element 51 which make use of a controlled delaminating material. Interlocking a full pallet saves packages from damage or from distorting during distribution. Individual packages 50a-g are collated by the attachment of a connecting element 51, for example a carton board sheet 51. The surface, or parts of the surface, of the board sheet 51 facing the packages is printed with active layers 53, 54 and a bonding layer possessing adhesive as well as conductive properties is applied between the active layers 53, 54 and the packages 50 to be interlocked.

Fig 9 shows an example wherein a first circuit 9a is printed at a carton board sheet 51. A second circuit 9b is printed on the board sheet at a distance from the first circuit 9a. In connection with said first circuit 9a, a first set of active surfaces 53 are arranged at short intervals on said board sheet. A second set of active surfaces 54 are arranged in connection with said second circuit 9b. Respective second active surface 54 is arranged at a small distance from respective first active surfaces 53. This has been disclosed in more detail with reference to fig 2-5.

Respective active surfaces 53, 54, arranged at a small distance from each other, form a pair of active surfaces 53, 54. A bonding layer is applied between the active surfaces 53, 54 and the packages 50a-g. The bonding layer is applied in spots such that each spot covers each pair of active surfaces 53, 54. The set of active surfaces 53, 54 and electrically weakable adhesive forms an electrically weakable adhesion area. As shown in fig 9 a plurality of such pairs of active surfaces 53, 54 and the accompanying electrically weakable adhesive is arranged along the circumference of the connecting element 51.

The active surfaces 53, 54 are of different materials with different potentials. Preferably, also the circuits 9a, 9b are of respective materials of different potentials. The circuits 9a, 9b may be connected by a switch 7. When the switch is open, no current flows through the bonding layer 55. When the switch is closed, current will flow through the bonding layer between the active surfaces 53, 53 thereby causing bonds in the bonding layer or between the bonding layer and one or both of the active surfaces 53, 54 to break or to weaken.

In an alternative embodiment for holding packages together, the packages may be held together directly using controlled delaminating materials. In one example of this embodiment, multi packs are held together and

released after purchase. Such a design is shown in fig 10a-b.

Fig 10a is a schematic drawing, which shows an example wherein two packages are adapted to be held together using controlled delaminating materials. The packages has been separated slightly in order to make all components visible.

In fig 10a-b, the left package 60a is provided with a double connector circuit 9a, 9b (as shown in detail in fig 9 and a switch 7 located on an accessible side 60a' of the package 60a. The circuits 9a, 9b extends to a surface 61a facing a neighbouring package 60b. The circuits 9a, 9b extend essentially along the perimeters of the surface 61a facing the neighbouring package 60b and are as shown in detail in fig 10b provided with active surfaces 63, 64 and an electrically weakable adhesive layer 65.

Thus, in this example, the side 61a of the package 60a forms the first carrier layer. The active surfaces 63, 64 and the circuits 9a, 9b may be arranged on the said surface 61a of the package 60a in a pattern similarly to the one described above with reference to fig 9 (shown in detail in fig 2-5). Spots of bonding layers may be applied between each pair of active surfaces and the side 62b of the other package 60b facing the first package 60a, whereby the packages are glued together. When the circuit 9a, 9b is open no current flows through the bonding layer 65, and the packages 60a, 60b remains glued together. When the circuit 9a, 9b current will flow through the bonding layer 65 causing bonds therein or between the bonding layer 65 and one or both of the carrier layers 61a, 62b to break or to weaken, and the packages may easily be separated. As an example, the circuit 9a, 9b may be closed by the user pressing a button arranged on the outside on the package, which causes a switch 7 to close. The current needed to break or weaken the bonds may be applied by forming the

active surfaces 63, 64 of different materials with different potentials.

Further layers may be applied between the two connected surfaces of the packages; such layers may be insulating layers, further conducting layers or layers of conventional adhesives as described above.

Fig 11a-b shows a set of secondary articles in the form of a cup 71 and a saucer 72 connected to a handling element 70.

The handling element comprises a first adhesion area 73 to which the cup 71 is connected and a second adhesion area 74 to which the saucer is connected. The adhesion areas 73, 74 are located on opposite sides of a disc or board shaped handling element 70. The handling element 70 comprises further an engagement portion 70a in the form of an extension provided with a through-going opening for hanging the handling element (with the thereto connected cup and saucer) on a display rack. The handling element is further provided a first active surface and second active surface. The active surfaces are formed of different materials with different potentials. The handling element is further provided with circuitry 6 for connection of the active surfaces to each other. Basically, the adhesion area comprises an electrically weakable adhesive and may be designed in accordance with the disclosure above.

Fig 12 shows a handling element 80 connected to two secondary articles in the form of two packages 81 and 82.

The handling element is provided with two adhesion areas 83 and 84 and forms a sling with the engagement area 80a located between said adhesion areas 83, 84. The two adhesion areas 83, 84 of the handling element 80 may be connected to one and the same secondary article (or package). One or more of the packages may be of the kind adapted to be temporarily connected to each other as described above. The packages connected to the handling element may also be connected to each other at the bottom

(or top) using a connecting element as described above. The manner of providing the voltage to the electrically weakable adhesive of the adhesion areas 83, 84 may be accomplished by providing two active surfaces of different materials with different potentials as discussed in detail above.

The packages described in the following make use of an electrically weakable adhesive material. Fig 10a-b, fig 13a-b and fig 14 discloses examples of uses and applications in different kind of packages.

Fig 13a-b discloses in cross-section a package provided with a closure adapted to be opened using the electrically weakable laminated structure described above.

The package comprises a top panel 20, a bottom panel 21, a front panel 22, a back panel 23 and two side panels (in front of and behind the cross-section of fig 13a-b). A closure flap 24 is connected to or integrally formed with the top panel 20. The closure flap 24 is folded relative to the top panel 20, extends along a portion of the front panel 22 and is fastened to the front panel 22 using the electrically weakable laminated structure described above.

Two active surfaces 3, 4 are arranged side by side, but not in direct contact, on one side of the opening closed by the top panel 20. The active surfaces 3, 4 are arranged on the outside of the front panel 22 facing the closure flap 24. A bonding layer 5 is applied between the active surfaces 3, 4 and the closure flap 24, thereby bonding the active surfaces 3, 4 to the closure flap 24. An electrical circuit 9 is provided to electrically connect the active surfaces 3, 4. The circuit is schematically drawn to include a switch 7 and a voltage supply 6. The voltage is provided by forming the active surfaces 3, 4 of different materials having different potentials. This has been discussed in more detail with reference to basic laminate structure of fig 1-5.

In fig 13a, the switch 7 is open, no current flows through the bonding layer 5 and the closure flap 24 remains bonded to the active surfaces 3, 4 and, consequently, to the front panel 22. In fig 13b, the switch 7 is closed, a closed circuit is formed, current flows through the bonding layer 5, thereby causing bonds in the bonding layer 5 or between the bonding layer 5 and one or both of the active surfaces 3, 4 to break or to weaken, whereby the package may easily be opened.

Fig 13a-b is a schematic picture showing the principle. Although not shown in fig 13a-b, the circuit 9 and the switch 7 may be arranged such that the user that wants to open the package presses a button arranged on the outside of the package, which causes the switch to close and the bonds in the bonding layer to break or to weaken. Furthermore, insulating layers may be arranged in order to separate the active surfaces 3, 4 out of the plane as described above with reference to fig 2-5 and a conventional non-conducting adhesive may be arranged between the bonding layer 5 and the closure flap 24. It may also be noted that, in contrast to fig 13a-b where the front panel 22 constitutes the first carrier layer 1 and the closure flap 24 constitutes the second carrier layer 2, the closure flap 24 may constitute the first carrier layer 1 and the front panel 22 of the package may constitute the second carrier layer 2.

Fig 14 shows another embodiment of a package adapted to be opened by the application of an electrical force, which package comprises two parts, a container 30, which is adapted to receive a product, and a cap 31. The package may for example be a bottle, but any kind of package is possible. The active surfaces 3, 4 are arranged at a distance from each other on the surface of the cap 31 facing the container 30. A bonding layer 5 is applied between the active surfaces 3, 4 and the surface of the container 30 facing the cap 31. The bonding layer 5 glues the cap 31 to the container 30. The active layers

3, 4 are connected by a circuit 9 comprising a switch 7 and a voltage supply 6. The voltage is provided by forming the active surfaces 3, 4 of different materials having different potentials. When the switch 7 is open, no current flows between the active surfaces 3, 4 or through the bonding layer 5 and the cap remains glued to the container 30. When the switch 7 is closed and current flows through the bonding layer 5, the bonds in the bonding layer 5 or between the bonding layer 5 and one or both of the active surfaces 3, 4 are broken or weakened, whereby the container 30 may easily be opened.

Furthermore, insulating layers may be arranged in order to separate the active surfaces 3, 4 out of the plane as described above with reference to fig 2-5 and a conventional non-conducting adhesive may be arranged between the bonding layer 5 and the container 30 or the cap 31. It may also be noted that, in contrast to fig 14 where the cap 31 constitutes the first carrier layer 1 and the container 30 constitutes the second carrier layer 2, the container 30 may constitute the first carrier layer 1 and the cap 31 may constitute the second carrier layer 2.

The inner envelope surface of the cap 31 and the outer envelope surface of the neck of the container 30 may be threaded, whereby the cap is screwed on the container. The threads may extend about the complete circumference of the neck or only partly as in a bayonet connection often used in glass jars and metal lids. In such an embodiment the controlled delaminating material may serve as a tamper proof or as an easily breakable sealing layer.

Claims

1. Laminate structure comprising

a first active layer having a first electrode potential,

a second active layer having a second electrode potential,

wherein the second electrode potential being different from the first electrode potential,

wherein the first and second active layers are arranged at a distance from each other, and wherein the laminate further comprises

a third layer of an electrically weakable adhesive at least partly bridging said distance between the first and second layers.

2. Laminate structure according to claim 1, wherein the third layer bridges said distance between the first and second layers.

3. Laminate structure according to claim 1, wherein said distance between the first and second active layers is bridged by the third layer and a fourth layer formed of an electrically conductive adhesive.

4. Laminate structure according to anyone of claims 1-3, further comprising a first substrate with a surface supporting the first and second active layers, wherein the first active layer is separated from the second active layer a distance along the surface of the first substrate.

5. Laminate structure according to claim 4, wherein the first substrate is formed of a non-conductive material.

6. Laminate structure according to claim 4 or 5, wherein the first substrate is formed of paper board.

7. Laminate structure according to claim 4 or 5, wherein the first substrate is formed of plastic.

8. Laminate structure according to anyone of claims 4-7, wherein the first substrate is connectable to a second substrate, wherein the electrically weakable adhesive is arranged to be located between the first and second substrate.

9. Laminate structure according to claim 8, further comprising a non electrically weakable adhesive arranged as a layer arranged to be located between the electrically weakable adhesive and the second substrate.

10. Laminate structure according to anyone of claims 1-9, further comprising a plurality of said first active layer of a first material having a first electrode potential, and a plurality of said second active layer of a second material having a second electrode potential, wherein said first and second layers are arranged in a plurality of pairs, wherein respective first active layer and respective second active layer of each pair is separated from each other a distance, and wherein each distance, apart from a least one distance being bridged by the electrically weakable adhesive, is bridged by an electrolyte material, and wherein the pairs are connected to each other by connecting the first active layer of a first pair to the second active layer of a second pair.

11. Laminate structure according to claim 10, further comprising a first substrate with a surface supporting said plurality of first and second active layers, wherein each respective first active layer is

separated from each respective second active layer a distance along the surface of the first substrate.

12. Laminate structure according to anyone of claims 1-11, further comprising a switch member by which the first and second active layers are electrically connectable to each other.

13. Laminate structure according to anyone of claims 1-11, further comprising a first connector electrically connected to the first active layer and a second connector electrically connected to the second active layer, wherein the first and second connectors are adapted to be electrically connected to each other by an external connector.

14. Method of releasing a laminate structure for opening or releasing a package or releasing a connecting element, comprising

providing a first active layer having a first electrode potential,

providing a second active layer having a second electrode potential,

wherein the second electrode potential being different from the first electrode potential,

wherein the first and second active layers are arranged at a distance from each other, and

providing a third layer of an electrically weakable adhesive at least partly bridging said distance between the first and second layers,

releasing the electrically weakable adhesive by electrically connecting the first and second active layers.

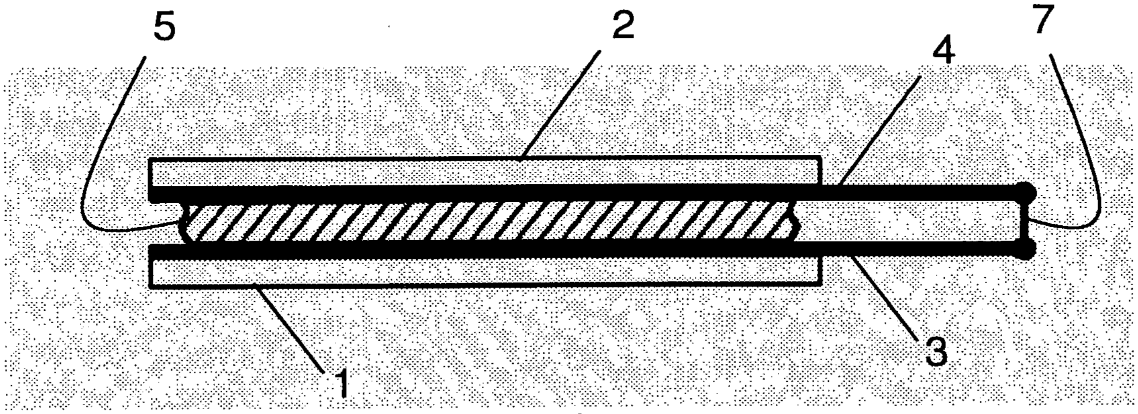


Fig 1

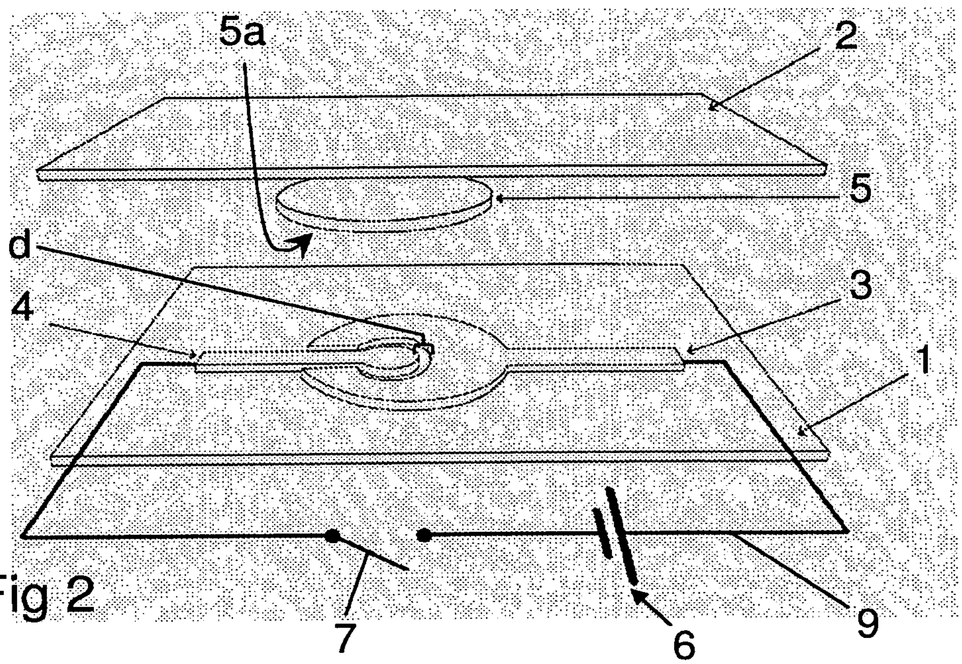


Fig 2

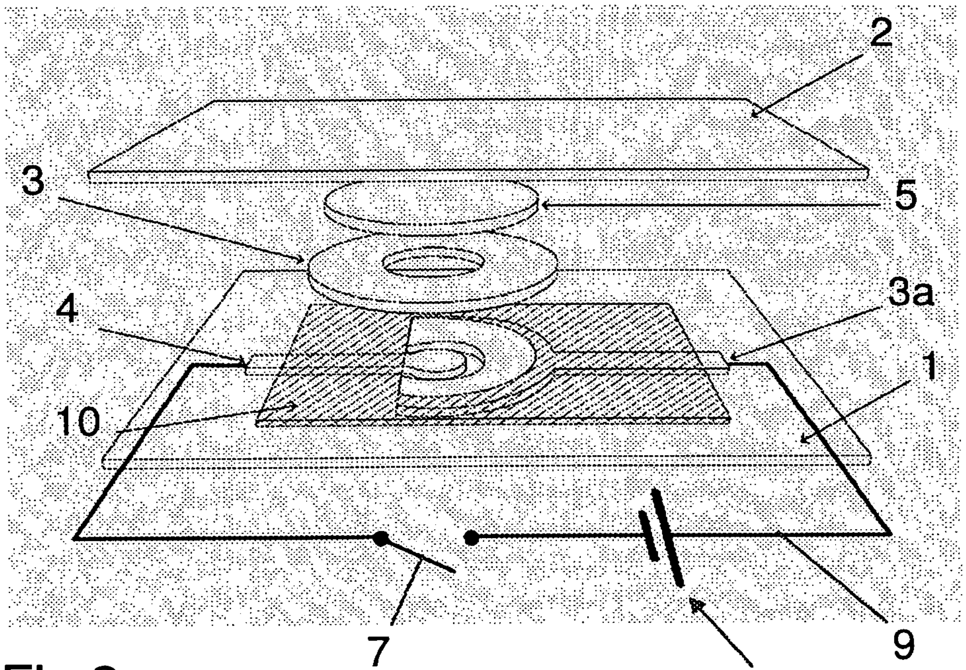


Fig 3

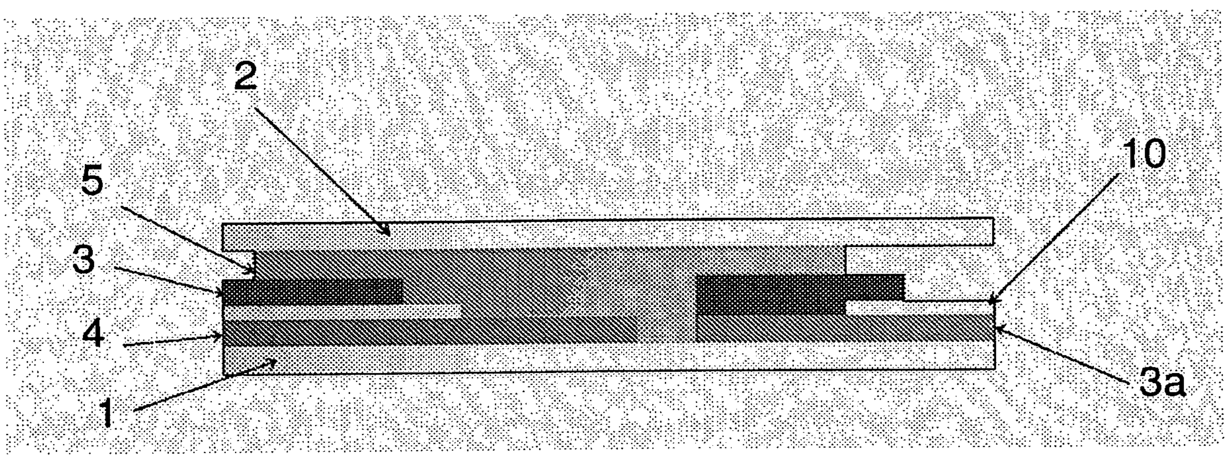


Fig 4

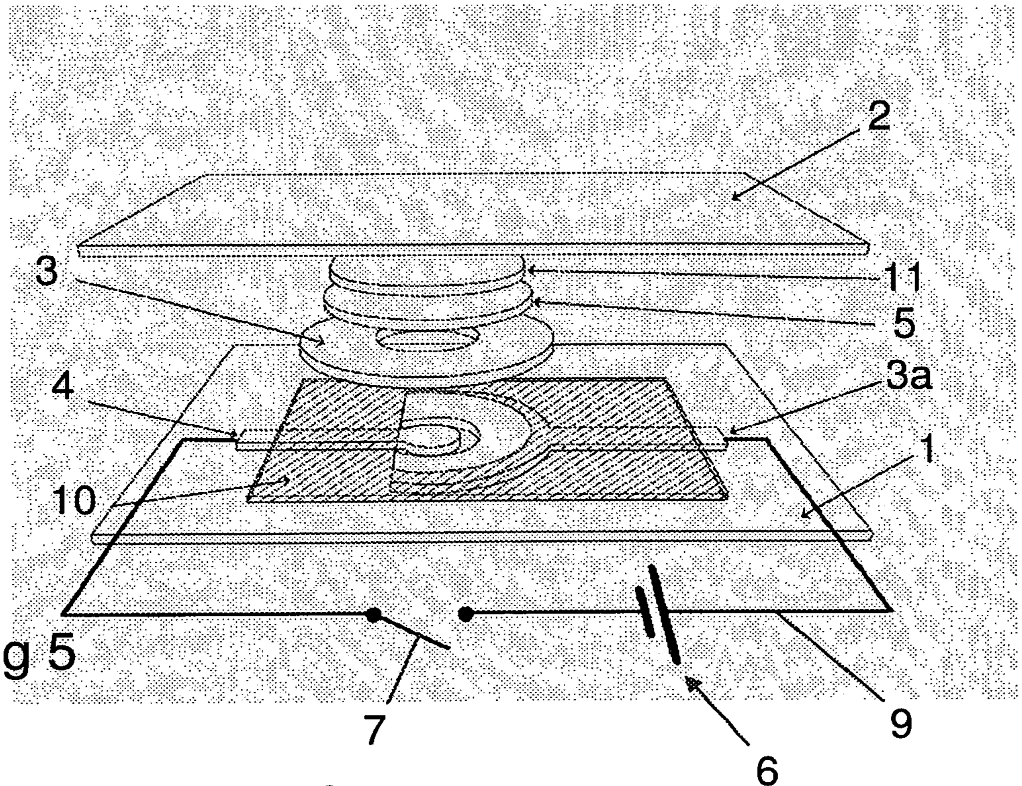
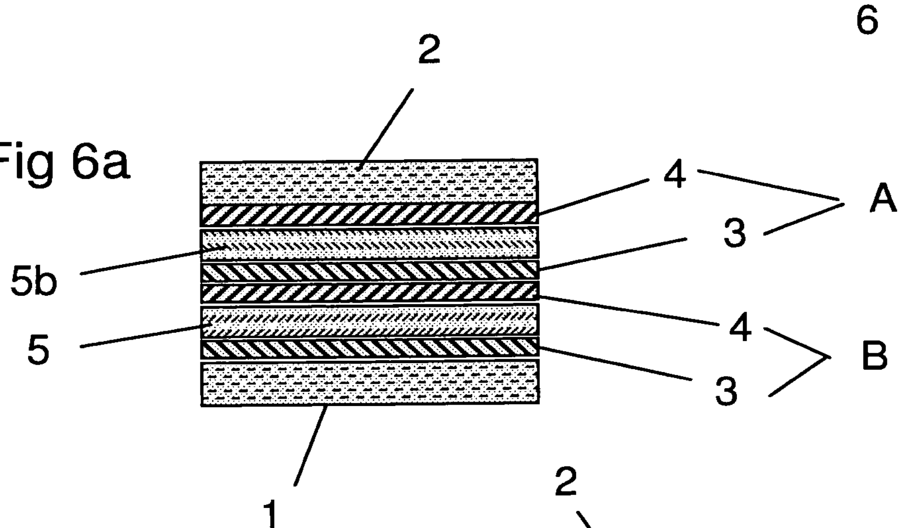


Fig 5

Fig 6a



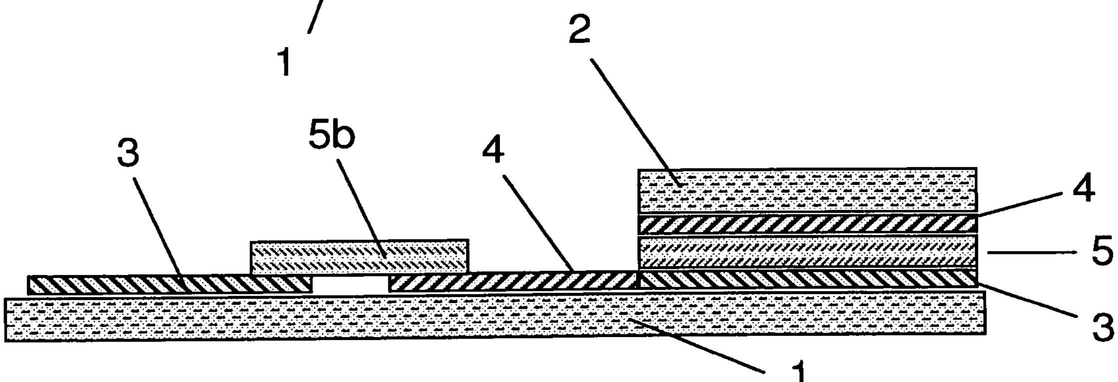


Fig 6b

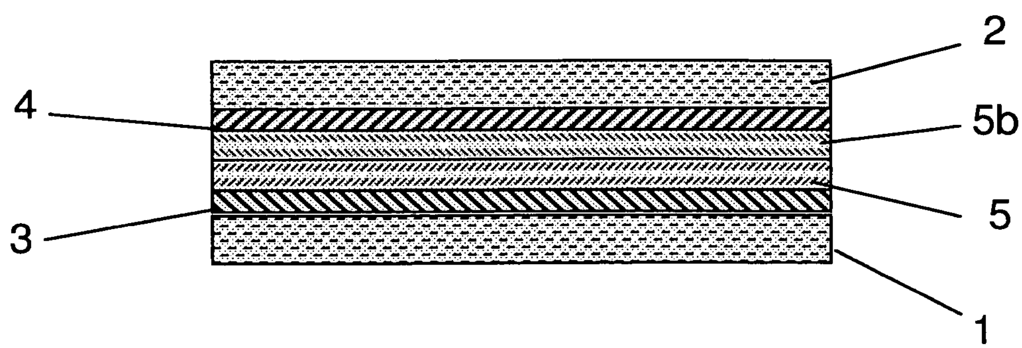


Fig 7

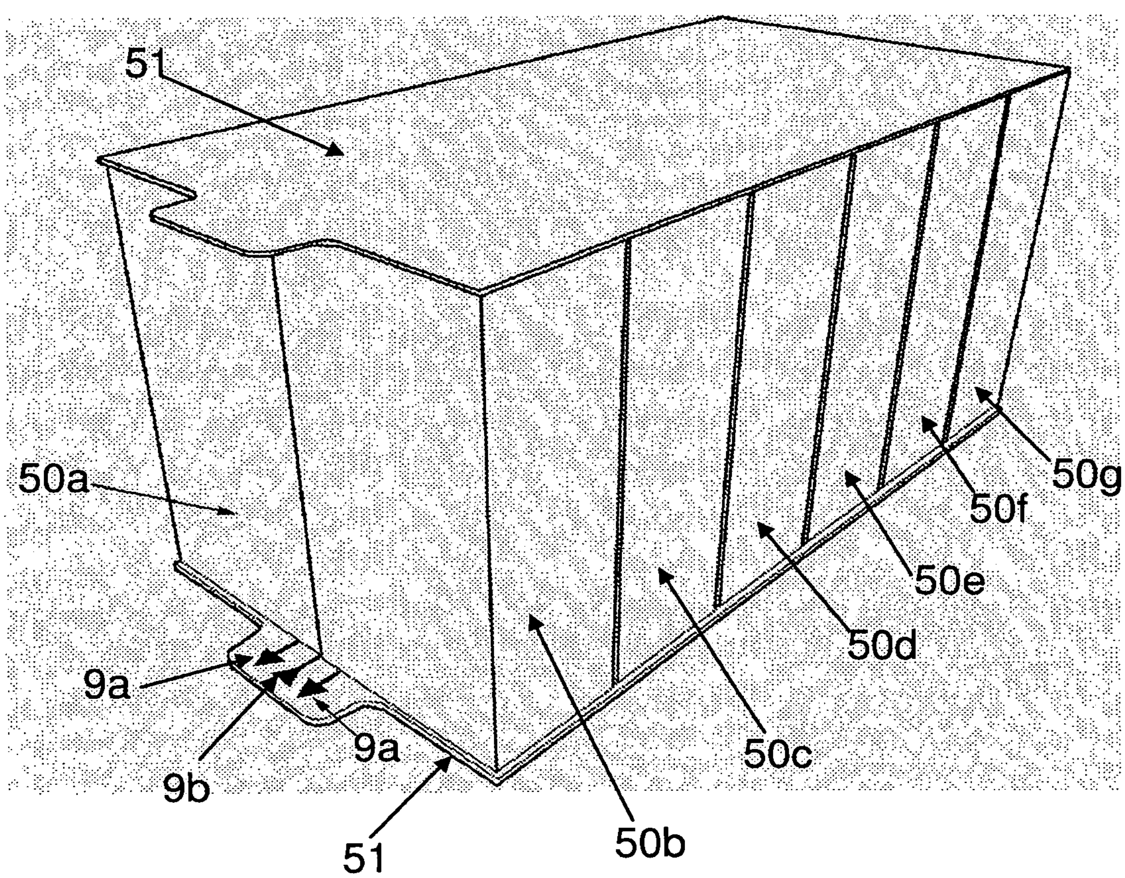


Fig 8

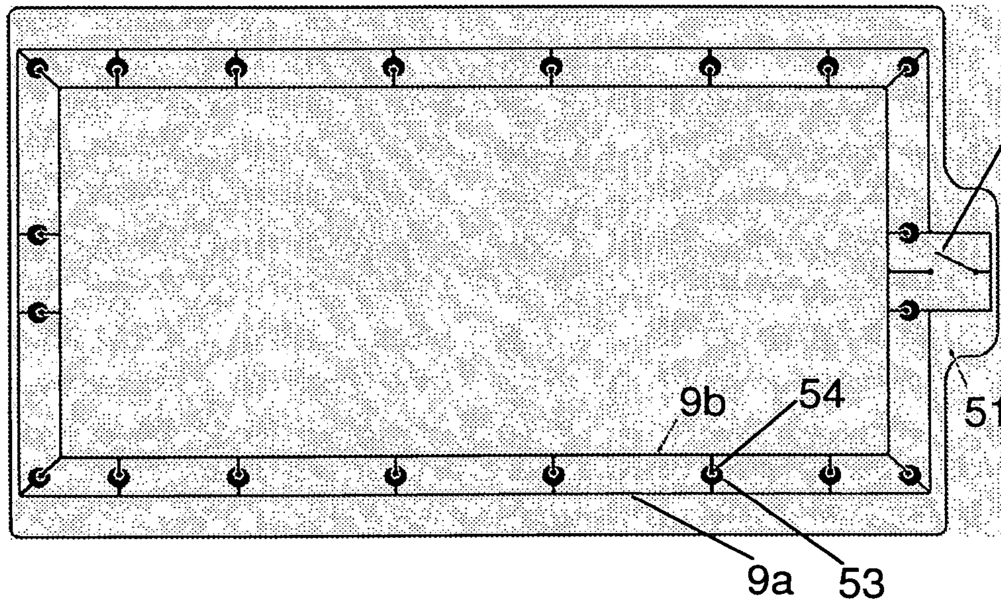


Fig 9

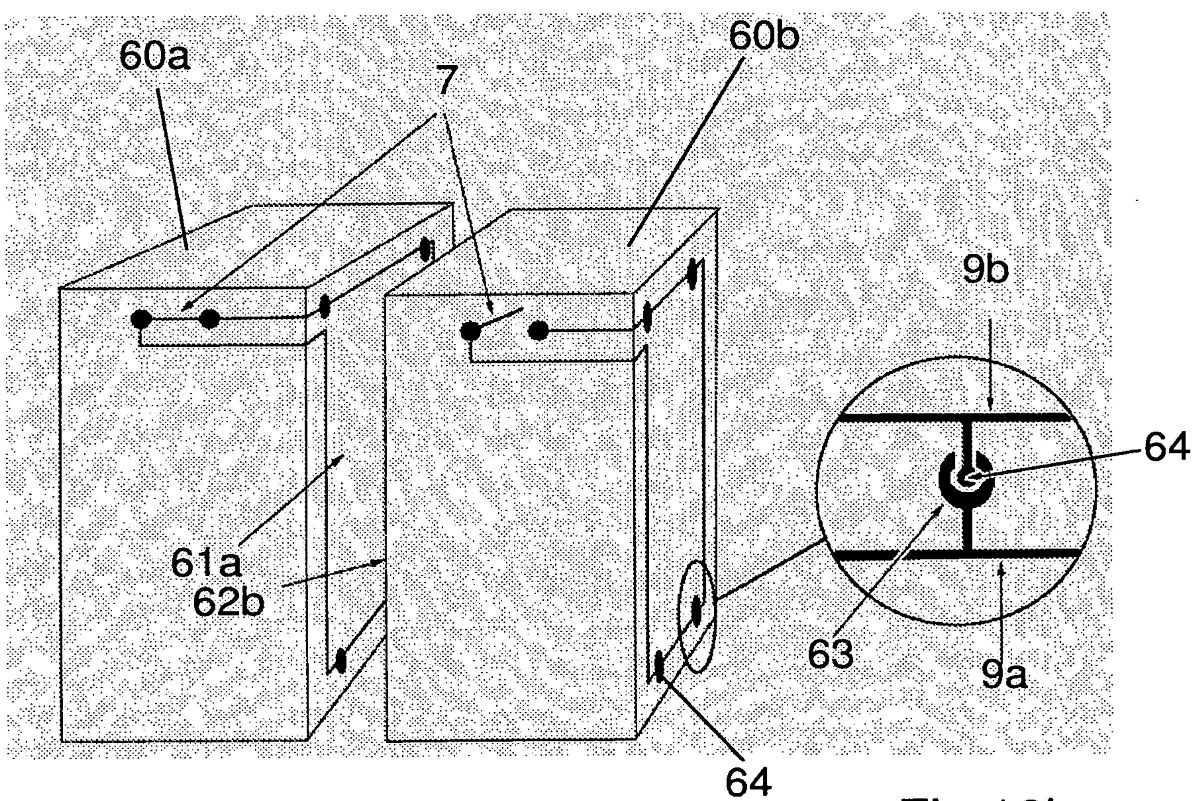


Fig 10a

Fig 10b

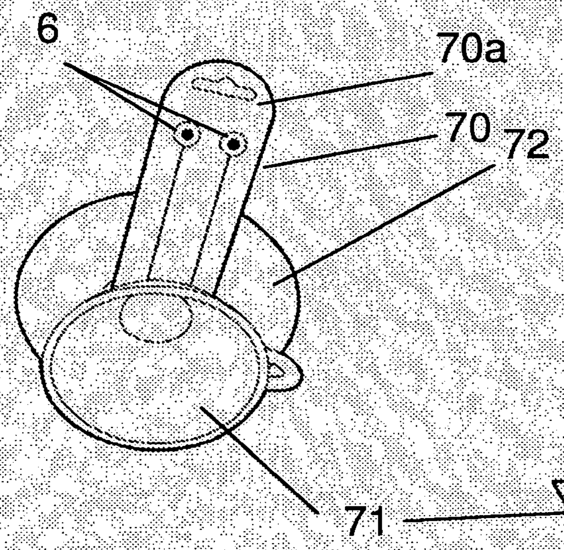


Fig 11a

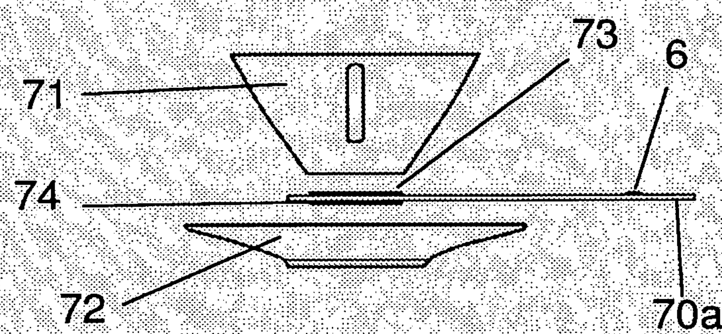


Fig 9b

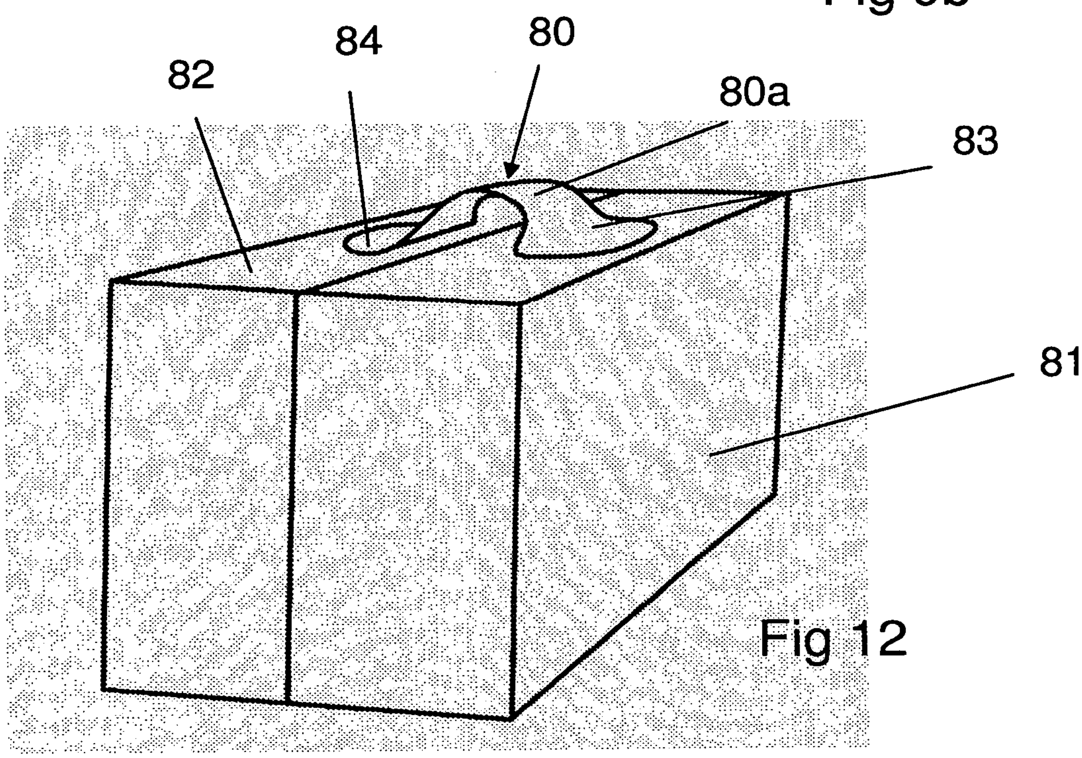


Fig 12

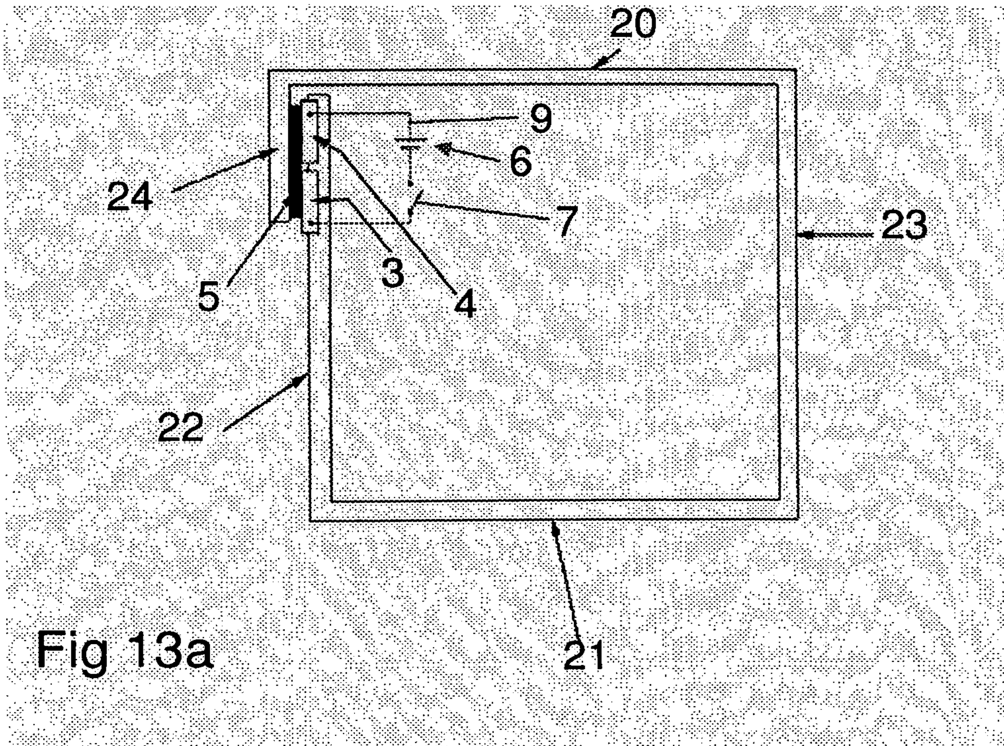


Fig 13a

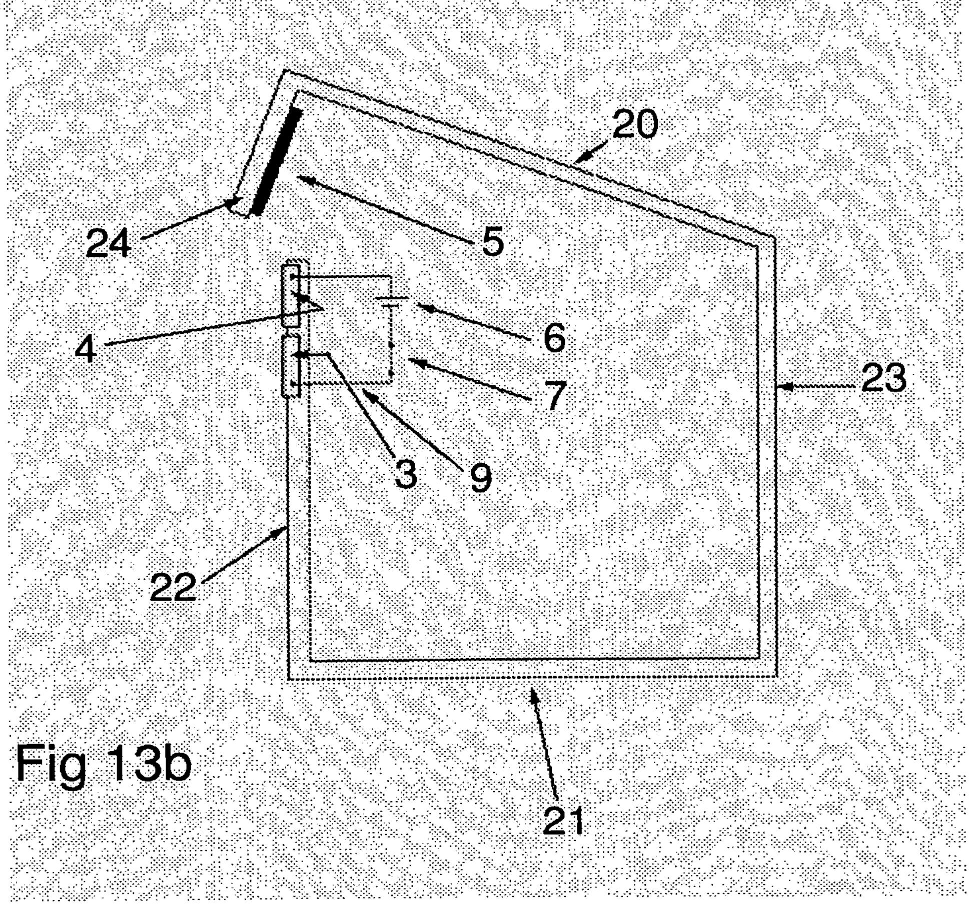


Fig 13b

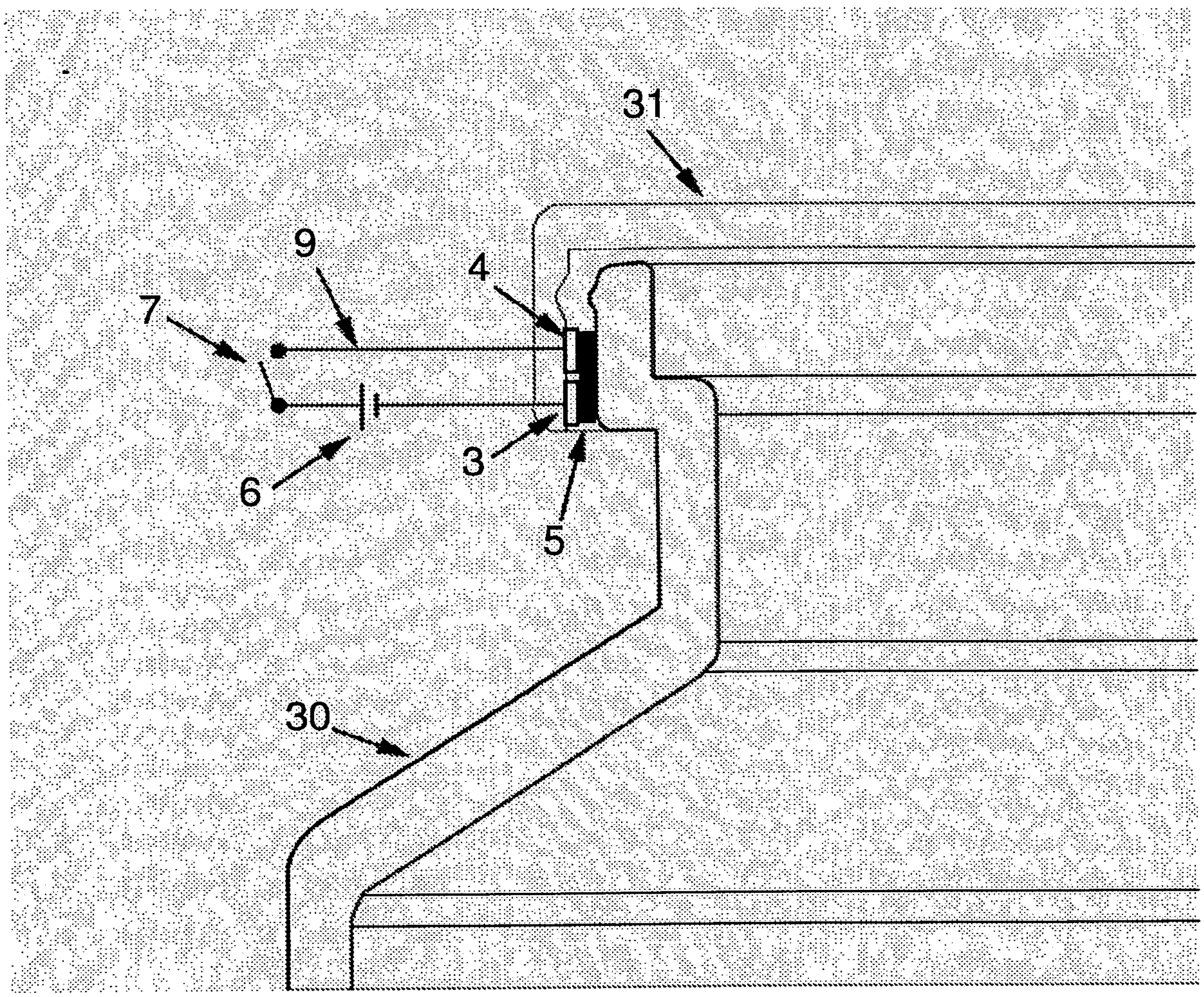


Fig 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/050265

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B32B, B65D, B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Electronic Smart Packaging: Market Research Report, Published by: IDTechEx Ltd,(Online), Published 1 July, 2004, page 227, (retrived on 2006-11-06). Retrieved from the internet: //www.marketresearch.com/mpa/prod/1147168.html, figure 3.15, chapter 3.5.4, pages 78-79 --	1-3,10-14
A	US B26620308 B2 (MICHAEL D. GILBERT), 16 Sept 2003 (16.09.2003), column 3, line 65 - column 4, line 4, figure 6A, abstract --	1-14
A	WO 2006050340 A2 (BARINOV, VICTOR), 11 May 2006 (11.05.2006), page 10, line 7 - page 11, line 24; page 13, line 10 - line 14, figure 2, abstract --	1-14

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2006	28-11-2006
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Monika Bohlin/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/050265

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3629092 A (PERCY F. GEORGE), 21 December 1971 (21.12.1971), abstract --	1-14
A	DE 1432090 A (D'ANDREA ET AL), 5 December 1968 (05.12.1968), page 3, paragrap 2, page 4, paragraph 1; claim 1-5 -- --------	1-14

International patent classification (IPC)
B32B 7/12 (2006.01)
B32B 43/00 (2006.01)
B32B 7/06 (2006.01)
B29C 65/76 (2006.01)
B65B 17/02 (2006.01)
B65B 69/00 (2006.01)
C09J 9/02 (2006.01)

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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

US	B26620308	B2	16/09/2003	NONE		
WO	2006050340	A2	11/05/2006	NONE		
US	3629092	A	21/12/1971	US	3772139 A	13/11/1973
DE	1432090	A	05/12/1968	NONE		